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Environmental Protection Operations
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Lupin Gold Mine Technical Advisory Panel (TAP)

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April 3, 2007

Please find enclosed the "Addendum Report to the Environmental Effects Monitoring Cycle 1 Interpretive Report for the Lupin Mine" submitted by Kinross Gold Corporation. I have read the amendment and feel that it adequately addresses concerns raised by the TAP during review of the "Lupin Gold Mine Environmental Effects Monitoring Cycle 1 Interpretive Report". However, if you have any comments or concerns with the facility's responses, please let me know by April 23, 2007.

Thank-you,

Bev Ging

Beverly Gingras, M.Sc.
Environmental Effects Monitoring Coordinator

cc Dorothy Lindeman, Environment Canada

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26 February 2007 **05-1373-019**

ENVIRONMENTAL PROTECTION OPERATIONS DIVISION

Prairie and Northern Region
Room 200, 4999 – 98 Avenue
Edmonton, Alberta T6B 2X3

ATTN: Shauna Sigurdson
Regional Director, Regional Authorization Officer

RE: ADDENDUM REPORT TO THE ENVIRONMENTAL EFFECTS MONITORING CYCLE 1 INTERPRETIVE REPORT FOR THE LUPIN MINE

Dear Ms. Sigurdson,

On 6 December 2006, Environment Canada's Technical Advisory Panel (TAP) provided review comments to the "Lupin Gold Mine Environmental Effects Monitoring Cycle 1 Interpretive Report". As requested by Environment Canada, responses to the comments are addressed in the present addendum report. TAP comments and questions are provided (*italics*) for each of the responses provided below.

General Comments

1. *Overall, this report is clear and well written. The information is nicely summarized in graphs, tables and text. The TAP also appreciates the QAQC information provided.*

The study was a collaborative effort among personnel from Golder Associates Ltd. (Golder) and Kinross Gold Corporation, Lupin Operations (Kinross). Golder and Kinross appreciate Environment Canada's expression of gratitude.

Site Characterization

2. *p. 2-18: it is noted that water quality data from 2000 and 2002 demonstrate that there is adequate mixing in Outer Sun Bay. Was any of the 2005 data considered in this evaluation? Based on Table 2.7, it appears that some of the water quality parameters have increased slightly at station 925-25 in Outer Sun Bay. Is this data still consistent with the dilution and dispersion model?*

The modelling was conducted in the fall of 2004, and would have only considered the 2000 and 2002 data (Golder 2004). The 2006 interpretive report only considered 2000 and 2002 data.

Dilution and dispersion modelling of the effluent into Outer Sun Bay was based on generalized flow and wind conditions, and assumptions about the geometry of the bay and narrows. For the month of July, regional hydrology indicated a combined discharge of approximately 11 m^3/s from Seep and Concession creeks. Combined with the effluent discharge, this would give effluent concentrations of 5.9 and 7.3% at the narrows under average and worst case conditions. Meteorological data indicated that the predominant July wind is from the east with a mean speed of 17 km/h and a 90th percentile speed of 31 km/h. Using an assumption that current speed is 3% of wind speed (Dejiang Long, personal communication 2003, as cited in Golder 2003a), this would yield current speeds of 0.15 and 0.26 m/s in the bay for mean and worst case conditions.

When used as model parameters, these conditions produce an estimated effluent concentration, at Survey Network Point (SNP) 925-25, of approximately 1.6% for mean conditions and 2.1% with worst-case conditions. Stagnant wind conditions produced concentrations of 2.3 and 2.9% at SNP 925-25 for the mean and worst case discharges. Winds blowing into the bay would produce higher effluent concentrations, as wind induced lake currents would counteract the effluent plume velocity.

Based on available water quality data from 2005, it appears that concentrations higher than estimated by the model are present in Outer Sun Bay. The estimated effluent concentrations range from 0.0 % to greater than 100 % (Table 1). Dilution calculations are based on the mean of the samples, taken during the discharge period, for the Effluent and Outer Sun Bay. Consideration has been made for background concentrations of the constituents by subtracting the corresponding constituent level as sampled at Concession Creek (SNP 925-21

These data generally are consistent with the dilution model, except for the lead concentration, which appears to be anomalously high. Lower lead concentrations were observed at the Sun Bay Narrows (0.0005 mg/L; Table 2.6, Golder 2006). Runoff volumes in 2005 were lower than modelled, giving lower than expected effluent dilution, and consequently higher effluent concentrations. In 2005, mean effluent concentration in Sun Bay Narrows was 9.4 %. When the 2005 data are incorporated into the dispersion model, effluent concentrations accounted for approximately 2.0 to 5.4 % of the water in Outer Sun Bay (i.e., SNP 925-25). When the dry conditions of 2005 are taken into consideration and that the modelled 1% dispersion limits are up to 1630 m beyond the SNP 925-25 sample site, the 2005 data are consistent with the dilution and dispersion model.

Table 1 Estimated effluent concentrations in Outer Sun Bay, 2005

Constituent	Units	Concentration (mean) at SNP 925-10 (effluent)	Concentration (mean) at SNP 925-25 (Outer Sun Bay)	Effluent Concentration (%)
Arsenic	mg/L	0.0097	0.0013	6.7
Conductivity	µS/cm	846	30	2.3
Copper	mg/L	0.016	0.001	0.0
Cyanide	mg/L	0.039	0.002	0.0
Lead	mg/L	0.0004	0.0006	141
Nickel	mg/L	0.0970	0.0026	2.2
Zinc	mg/L	0.257	0.011	3.5

Note: Means were calculated from data collected during the discharge period. SNP 925-10 *n=28*; SNP 925-25 *n=4*.

Water Quality and Sediment Quality

3. *p. 4-10: Table 4-4 Conductivity measurements suggest that FC3 may be influenced by Contwoyto Lake. Please comment.*

A prominent sandbar divided Contwoyto Lake from Fingers Creek (FC3). Both ponded water and low velocities were observed at the downstream end of Fingers Creek, and water flow into Contwoyto Lake was limited to seepage through the sandbar. The elevated conductivity values observed at the downstream end of the creek was more likely a result of site-specific stream conditions rather than influence from Contwoyto Lake. Conductivity data were not collected from Contwoyto Lake at the time of the survey; however, past studies have generally reported conductivity values of less than or equal to 12 µS/cm (see data reports provided in Golder 2003b).

4. *p. 4-11: Table 4.5, it is noted that the Seep Creek Ponds composite sample had elevated lead concentration. None of the SNP samples from the exposure area demonstrated high lead concentrations. No explanation is given. Could this sample have been contaminated during mixing?*

To the best of our knowledge, the Seep Creek Ponds composite water sample was not contaminated during sampling. Standard water sampling techniques were used to fill the containers, and bottles were securely sealed for transport. Every effort was taken to prevent contamination.

5. *p. 4-11: In section 4.2.1.3., it is not clear whether the holding time for pH was exceeded for all of the samples or only the field and trip blanks.*

The recommended maximum holding time for samples undergoing pH analysis is 48 hours. Because of challenges associated with the remote field location and limitations on shipping availability, the holding time was exceeded for all of the water samples shipped to the analytical laboratory. Field measurements for pH were also collected at most water quality sites to supplement the laboratory results.

6. *p. 4-12: Would the higher percentage of silt (greater surface area) in the reference sediments vs. the exposure sediments influence metal concentrations?*

The data indicate that silt composition and metal concentrations were higher in the exposure sediments compared to the reference sediments. In the response below, it is assumed that the TAP inadvertently reversed the sites and corresponding results in the question posed.

The higher percentage of silt in the exposure site could influence metal concentrations. In an aqueous environment, metals tend to sequester in the sediment layer. Smaller particles provide higher surface area, and thus a greater concentration of metals can bind to the sediment. Several articles in the primary literature have reported a positive relationship between metal concentrations and the proportion of fine particles in sediments (e.g., Moore et al. 1989; Axtmann and Luoma 1991; Filion and Morin 2000).

7. *p. 4-12: Is the difference in TOC statistically significant among areas?*

A single factor ANOVA (SPSS 2002) was used to determine if there was a difference in the amount of TOC between samples collected in the reference and exposure areas. Prior to conducting the ANOVA, data were arc-sine square-root transformed to normalize differences (Sokal and Rohlf 1995).

SPSS (2002) evaluates data for outliers. During the ANOVA computations, an outlier was detected. Based on Environment Canada's (2002) recommendation of using $\alpha=0.01$, results indicated that mean TOC concentrations were significantly different for the entire dataset ($P=0.058$) and when the outlier was removed ($P=0.086$).

8. *p. 4-12: Please note that descriptive summary statistics are required for TOC and PSA (Schedule 5, section 16 of the Metal Mining Effluent Regulations) Mean and standard deviation are presented in Appendix D but median, standard error, minimum and maximum values are not presented.*

Summary statistics for sediment TOC and particle size are provided below (Table 2). Such data will be included in subsequent reports.

Table 2 Summary of sediment characteristics

Endpoints	Seep Creek Ponds 1 & 2 (Exposure)					
	Mean	Median	SD	SE	Min	Max
Total Organic Carbon (TOC %)	1.6	0.5	1.8	0.8	0.4	4.3
Particle Size Analysis (PSA)						
Clay (%)	2.8	1.8	2.1	1.0	0.8	5.5
Silt (%)	44.1	48.6	28.0	12.5	9.7	78.6
Fine Sand (%)	28.8	29.6	22.6	10.1	4.6	52.4
Coarse Sand (%)	24.3	24.1	16.3	7.31	7.6	42.2
Gravel (%)	0	0	0	0	0	0

Endpoints	Fingers Lake (Reference)					
	Mean	Median	SD	SE	Min	Max
Total Organic Carbon (TOC %)	0.2	0.2	0.13	0.058	<0.1	0.4
Particle Size Analysis (PSA)						
Clay (%)	0.7	0.9	0.44	0.20	0	1
Silt (%)	3.7	4.0	2.8	1.3	0.7	6.7
Fine Sand (%)	41.1	43.7	5.10	2.28	34.4	45.4
Coarse Sand (%)	54.6	53.7	5.45	2.44	49.2	62.1
Gravel (%)	0	0	0	0	0	0

Benthic Invertebrate Community Survey

9. *The facility should be commended for identifying invertebrates down to the lowest practical level and including the raw data at both the 500 and 250 μm size fractions.*

TAP comments will be passed on to the analytical laboratory. Thank you.

10. *Benthic density at FL3 is quite high and appears to be driven by Orthocladiinae (Table E1). The TAP recommends that the location of that site be discussed before the next biological field program.*

Golder and Kinross are open to discussion and will consider recommendations the TAP would like to provide.

11. *p. 4-9: Were any in situ measurements taken at the Fingers Lake benthic invertebrate sites? EC staff who visited this site during the field program noted that some Oakton pens were available as backup to the Oakton meter. Was station depth recorded?*

The only *in situ* measurement taken at Fingers Lake was a turbidity reading (0.67 NTU), which was measured from the composite water sample.

Depths measured at the time of sediment core collection can also be used for benthic samples. Benthic samples were collected at the same stations as the sediment cores. Multiple Ekman grabs were required for each benthic invertebrate sample. The boat was anchored at the designated waypoint, and multiple samples were collected from various locations around the boat. Since, depths around the boat had limited variability, the depths provided for sediment core collected are representative of the depths for benthic sampling. These depths were as follows: FL1=1.0 m; FL2=0.80 m; FL3=0.80 m; FL4=0.8 m; and, FL5=1.3 m.

Fish Survey

12. *The TAP appreciates the clear presentation of data and the effective use of graphs and tables.*

Comment noted. Thank you.

13. *As per the TAP request (email from P. Siwik, June 8, 2005), please analyse the archived fish liver for copper. If data on other elements are included in the analytical suite, please present that data as well.*

Copper analyses for fish liver tissues are provided below (Table 3). Due to small sample sizes, statistical analysis of the copper data were not carried out as suggested by Environment Canada (2002); however, the copper concentration is 72% higher in the exposure livers than in reference livers. Results of the complete metal scan are attached.

Table 3 Total copper in composite liver samples

Location	Sample Identifier	No. of Livers	Sample Weight (g)	Moisture (%)	Total Copper (µg/g)[a]
Exposure	LUPO5UDIAPARGR001C	19	2.37	78.1	29.2
	LUPO5UDIAPARGR002C	17	2.08	81.9	29.2
Reference	LUPO5UF3ARGR001C	13	2.47	79.8	8.16
	LUPO5UF3ARGR002C	11	2.45	81.2	8.27
	LUPO5UF3ARGR003C	11	2.60	83.3	8.01

[a] Dry weight.

14. *p. 6-8: While fish were aged, no statistical analysis of age or age frequency distribution was presented.*

A length frequency histogram for all captured Arctic grayling was created to assess age classes (Figure 1). Fish scales were used to age a subset of fish to verify the results of the length frequency distribution. The three data groups in Figure 1 corresponded to three age classes - YOY, age 1, and age 2.

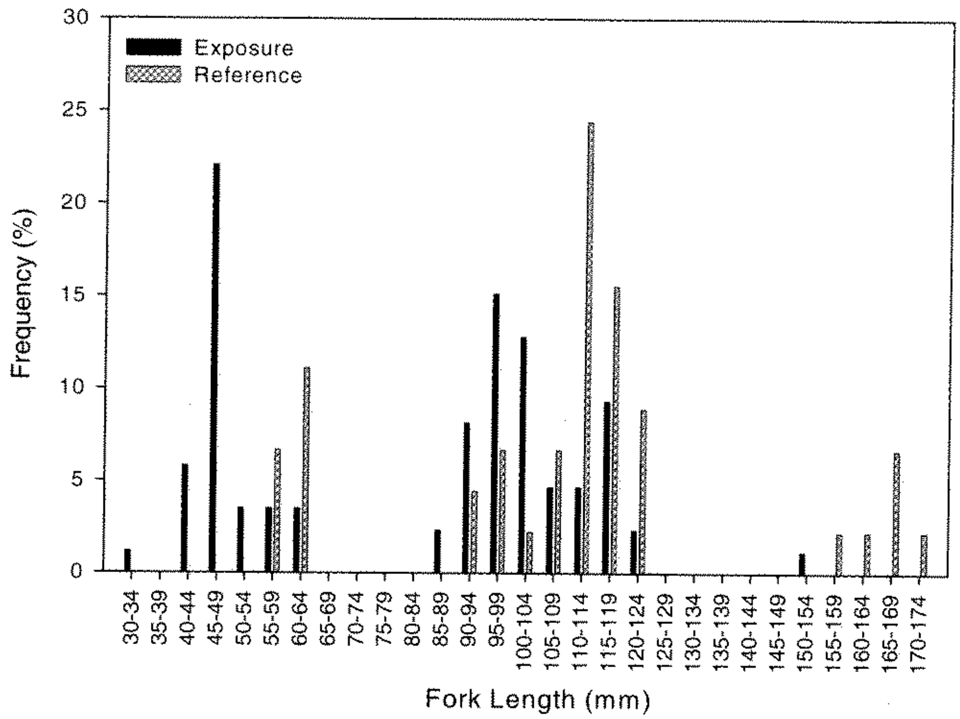

Figure 1 **Length frequency distribution of Arctic Grayling**

15. *A review of Appendix F indicates that there were not many YOY's caught in either Fingers or Seep Creek. Please confirm whether this is the reason why no separate analysis was done of the YOY data.*

A separate analysis was not conducted on the young of the year (YOY) Arctic grayling due to the limited number of YOY captured during the study. In total, 33 YOY were captured in Seep Creek (exposure) and eight YOY were captured in Fingers Creek (reference). For the same reason, data analyses also did not include age 2 fish. One age 2 fish was captured in the exposure area and six were captured in the reference area.

16. *Please include a summary of biological parameters for the YOY and age 2 fish collected in this survey.*

Data for YOY and age 2 Arctic grayling are provided below (Tables 4 and 5).

Table 4 Summary data for Arctic grayling YOY

Location	Variable	*n*	Median	Mean	SD	SE	Minimum	Maximum
Exposure	Fork length (mm)	34	48	49	6.1	1.0	32	64
	Total weight (g)	29	<2	<2	-	-	<2	2.2
Reference	Fork length (mm)	8	61	60	3.0	1.1	56	64

Table 5 Summary data for age 2 Arctic grayling

Location	Variable	*n*	Median	Mean	SD	SE	Minimum	Maximum
Exposure	Fork length (mm)	1	-	152	-	-	-	-
	Total weight (g)	1	-	18.9	-	-	-	-
	Carcass weight (g)	1	-	13.4	-	-	-	-
	Liver weight (g)	1	-	0.2	-	-	-	-
Reference	Fork length (mm)	6	166	165	4.86	1.98	158	171
	Total weight (g)	6	56.9	58.0	7.57	3.10	47.0	68.0
	Carcass weight (g)	6	48.2	48.9	6.98	2.85	38.8	58.7
	Liver weight (g)	6	0.5	0.5	0.05	0.02	0.4	0.5

17. *p. 6-12: While it may be generally true that electrofishing tends to select for larger individuals than gill nets, the raw data in this particular study does not support this statement. Based on a quick overview of the data from Seep Creek (no grayling were caught by a gill net in the reference area), it appears that the gill-netted grayling tended to be larger than those caught by electrofishing. This suggests that the difference between the exposure and reference areas might not have been significantly influenced by gear selectivity.*

It is agreed that the difference in Arctic grayling size between the exposure and reference areas is not likely to have been significantly influenced by gear selectivity. Gear selectivity was presented as a general acknowledgement that the use of different gear at different sample locations could influence sample results. However, it should also have been noted that the difference in gear selection was related to the difference in habitat type, which may influence sampling results. Backpack electrofishing was conducted in the exposure and reference creeks, and gill nets were set in the exposure ponds and the reference lake.

18. *p. 6-14: In Table 6.6, for all parameters, the direction of difference is listed as reference less than exposure, rather than exposure less than reference.*

Comment noted.

Sublethal Toxicity Testing

19. *p. 7-2: Please comment on the possible difference in chemical composition between July and August effluent.*

Kinross staff monitors effluent daily during the discharge period for pH, conductivity, temperature, total suspended solids, arsenic, cyanide, copper, and zinc. On 11 August 2005, effluent pH dropped below 6.0 (threshold for water licence) and discharge of mine effluent was terminated for the remainder of the year. The August sample that was submitted for sublethal toxicity testing was collected from tailings Pond 2 on 30 August. Kinross ceased ore processing in February 2005, and wastewater from mine clean-up activities in summer 2005 was held in a containment cell; therefore, there is no obvious explanation for the change in effluent water quality within tailings Pond 2.

Recommendations for Subsequent Biological Monitoring

20. *p. 9-1: TAP supports the recommendations made in this section and also suggests that a second fish reference site containing ninespine stickleback be considered in future studies.*

Golder and Kinross would be pleased to consider recommendations put forth by the TAP.

21. *During the next phase of biological monitoring, please confirm the estimate of effluent concentration at 250 m if possible.*

Effort will be made to meet this request during subsequent biological monitoring programs.

Minor Comments

22. *The MMGD state that field water quality measurements should be taken concurrently with the BIC and sediment sampling. It is understood that field water quality measurements could not be acquired in the reference area due to equipment malfunction, but there is no explanation given for the variation in dates between the BIC/sediment sampling and the field water quality measurements in the exposure area.*

The site names Seep Creek Pond 1 and Seep Creek Pond 2 and sampling stations were mislabelled for the water quality field measurements presented in Table 4.4 of the Environmental Effects Monitoring (EEM) interpretive report for the Lupin Mine. A revised Table is provided below (Table 6).

Table 6 Field-measured water quality variables (revised Table 4.4 of EEM report)

Survey	Location	Sampling Station	Date	Temperature (°C)	DO (mg/L)	pH	Conductivity (µS/cm)	Turbidity (NTU)
Fish Population	Exposure	Seep Creek Dam 1a Lake (SCD1)	29-Aug-05	4.7	12.3	5.3	740	0.9
		Seep Creek 1 (SC1)	19-Aug-05	11	n/a	5.6	126	n/a[a]
		Seep Creek 1 (SC1)	22-Aug-05	10.8	n/a	n/a	n/a	0.6
		Seep Creek 2 (SC2)	20-Aug-05	n/a	n/a	n/a	n/a	n/a
		Seep Creek 3 (SC3)	25-Aug-05	9.8	11	5.6	130	0.56
		Seep Creek 4 (SC4)	02-Sep-05	8.4	11.4	5.3	120	n/a
	Reference	Fingers Creek (FC3)	03-Sep-05	7.7	10.6	5.3	120	n/a
		Fingers Creek (FC2)	27-Aug-05	13.4	10.3	5.7	10	n/a
		Fingers Creek (FC1)[b]	05-Sep-05	8.1	10.6	5.9	10	0.54
Benthic Invertebrate Community	Exposure	Seep Creek Pond 1 (SCP3)	24-Aug-05	12	n/a	5.8	200	0.91
		Seep Creek Pond 1(SCP5)	05-Sep-05	13.6	11.7	5.7	130	n/a
		Seep Creek Pond 2 (~30m from SCP1)	22-Aug-05	10.8	n/a	5.9	110	n/a
		Seep Creek Pond 2 (SCP1)	24-Aug-05	n/a	n/a	n/a	n/a	1.46
		Seep Creek Pond 2 (SCP1)	06-Sep-05	12.1	11.2	5.9	90	n/a
		Seep Creek Ponds composite	05-Sep-05	n/a	n/a	n/a	n/a	2.36
	Reference	Fingers Lake composite[c]	05-Sep-05	n/a	n/a	n/a	n/a	0.67

[a] n/a = not available.
[b] Data for this station used as surrogate for Fingers Lake sampling stations.
[c] Composite sample from five sampling stations.

For Pond 1, water quality readings were collected on 24 August and 5 September. Benthic sampling occurred on 24 August, and sediment was collected on 5 September. For Pond 2, water quality readings were collected on 22 August and 6 September. Water quality was sampled on 22 August during the reconnaissance survey. Benthos was sampled on 24 August, and sediment was collected on 6 September. Water quality readings were not collected on 24 August. Water quality readings were collected at one location on each day, with the understanding that water quality reading could be generalized for the entire pond because the waterbody was shallow and well mixed. In the future, water quality readings will coincide with the date and sampling locations for each benthic and sediment sample.

23. *The term Cycle is not used in the Metal Mining EEM program as it is in the Pulp and Paper program. In the future, please include the year the study was done and the phase (e.g. confirmation phase, magnitude and extent phase etc) in the title of the report.*

Comment noted. In the future, Lupin Mine EEM reports will include year and phase in the report title.

CLOSURE

We trust that the above material meets your present requirements. If you have any questions or concerns, please feel free to contact Mark Dunnigan (780-930-8657) or Gary Ash (780-930-8666).

Sincerely,

GOLDER ASSOCIATES LTD.

Mark Dunnigan, M.Sc., P.Biol.
Aquatic Biologist

Gary Ash, M.Sc., P. Biol.
Senior Fisheries Biologist and Principal

cc: Mike Tansey, Kinross Gold Corporation, Edmonton, Alberta.
Bev Gingras, Environment Canada, Edmonton, Alberta.

MD/GA/SM/AH/BT/cb

Encl.

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Total metal concentrations in composite liver samples collected from the Lupin Mine EEM study area, 2005

Parameters	MRV[a]	MDL[a]	Exposure Area		Reference Area		
			LUP05UDIAP ARGR001C	LUP05UDIAP ARCR002C	LUP05UF3 ARGR001C	LUP05UF4 ARGR002C	LUP05UF5 ARGR003C
Number of Livers			19	17	13	11	11
Sample Weight (g)			2.37	2.08	2.47	2.45	2.6
Moisture (%)	0.01	0.01	78.1	81.9	79.8	81.2	83.3
Total Metals (μg/g)[b]							
Aluminum	0.0521	0.781	8.67	8.05	3.26	1.63	2.28
Antimony	0.0003	0.0003	0.0054	0.0029	0.0031	0.0018	0.0016
Arsenic	0.0013	0.0104	1.63	1.86	0.29	0.319	0.345
Barium	0.0026	0.026	0.359	0.387	0.405	0.488	0.398
Beryllium	0.0013	0.0026	0.0013	0.0025	0.0013	0.0013	0.0012
Bismuth	0.0002	0.0026	0.0034	0.0054	0.0102	0.0046	0.0062
Boron	0.013	0.208	0.645	1.26	1.02	0.393	0.456
Cadmium	0.00052	0.00156	0.349	0.297	0.0546	0.0628	0.0695
Calcium	1.04	13	588	753	1065	1090	1014
Chlorine	26	78.1	2592	518	2476	20403	28234
Chromium	0.013	0.078	2.19	3.84	0.39	0.378	0.516
Cobalt	0.0005	0.0026	1.96	2.11	1.12	1.23	1.26
Copper	0.013	0.026	29.2	29.2	8.16	8.27	8.01
Iron	5.21	10.4	380	366	290	309	309
Lead	0.00026	0.0026	0.495	0.335	0.0204	0.0115	0.0097
Lithium	0.0052	0.0521	0.0111	0.0241	0.014	0.0138	0.0167
Magnesium	0	0.1	820	863	844	838	883
Manganese	0.001	0.008	8.9	9.91	8.49	8.09	8.23
Mercury	0.0026	0.013	0.359	0.326	0.983	1.05	0.613
Molybdenum	0.00026	0.00208	0.51	0.488	0.369	0.363	0.408
Nickel	0.0013	0.0156	0.414	0.546	1.22	0.345	0.165
Phosphorus	2.6	13	16398	15823	12571	12998	13320
Potassium	2.6	13	12780	11311	12391	13458	14382
Selenium	0.026	0.052	3.8	3.6	3.46	3.55	3.86
Silicon	13	130	85	607	390	136	67
Silver	0.00016	0.0013	0.0869	0.0573	0.0199	0.0171	0.0166
Sodium	2.6	15.6	3123	2973	3592	3984	3933
Strontium	0.001	0.0021	1.06	1.25	2.43	2.6	2.22
Sulfur	26	130	13821	12134	13571	13943	13610
Thallium	0.00016	0.00078	0.163	0.142	0.0539	0.0488	0.0541
Thorium	0.00021	0.0078	0.0062	0.0106	0.0167	0.0042	0.003
Tin	0.013	0.0182	0.0259	0.0372	0.129	0.0715	0.0258
Titanium	0.01	0.018	46.3	45.4	41	37.8	37.6
Uranium	0.0002	0.0008	0.0012	0.0015	0.0005	0.0005	0.0004
Vanadium	0.0013	0.013	0.0781	0.0747	0.05	0.102	0.15
Zinc	0.01	0.05	110	109	96.5	95.3	94.8

[a] MRL= minimum reporting level; MDL=methodological detection limit.
[b] Dry weight.